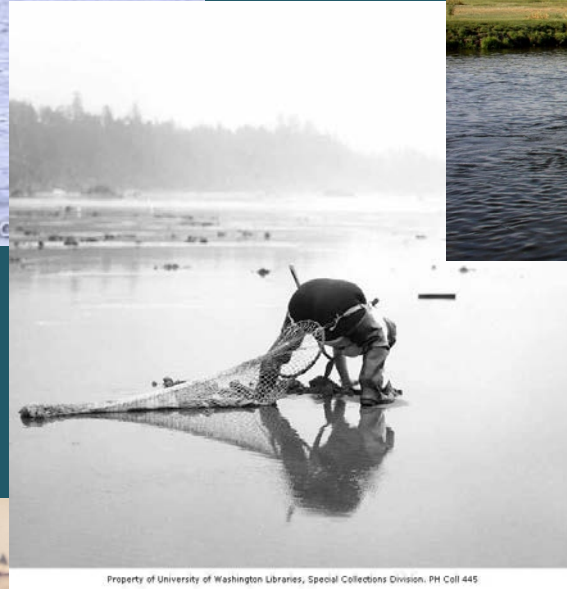




Fish Consumption Surveys and Ambient Water Quality Criteria

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Purposes for fish consumption surveys

1. To determine trends in seafood consumption
2. To determine fishing pressures on water bodies
3. To assess water body or site specific risks posed by contaminants in seafood.
 - a) Environmental regulation
 - b) Fish consumption advisories
 - i. Identification of water bodies where fish consumption advisories are needed
 - ii. Determine effectiveness of fish consumption advisories
4. To support development of water quality criteria

Fish consumption rates for ambient water quality criteria

- Fish (and shellfish) consumption rates (FCRs) in terms of the usual amount of fish consumed on a daily basis in uncooked weight.
- FCRs for species with contaminant body burdens that is due to contaminants in near coastal, estuarine, and inland waters (i.e. waters that might be under the jurisdiction of the Clean Water Act).
- FCRs for general population and high fish consumers.
- FCR statistics that represent central tendency and upper bound estimates of fish consumption.

Two types of surveys

Short term

- Pros:
 - Not cognitively challenging
 - Accurately record recent consumption
- Cons:
 - Variable
 - Difficult to predict long term consumption.
 - Can be difficult to predict consumption of infrequently consumed items

Food Frequency Questionnaire (FFQ)

- Pros:
 - Provides estimate of long term consumption
 - Found to have low variability
- Cons:
 - Not accurate predictors of long term intake
 - Cognitively challenging
 - Estimates affected by recent diet

National fish consumption data

- National Health and Nutrition Evaluation Survey (NHANES) data from 2003 to 2010
- Characterizes average intake on a national basis
- Individuals record two 24 hour recall intakes on non-consecutive days
- Consumers defined as individuals that consumed fish on either survey day
- Records some source information

Issues with the national data

- Representative of the United States but potentially not representative for specific regions
- Not representative of all minority groups
- Short observational period, designed to derive average consumption, is not ideal for predicting upper percentiles of consumption.
- Does not provide detailed source of fish information

National Cancer Institute (NCI) Model

- Statistical modeling developed by NCI required to convert short term dietary recall data into usual long term consumption.
 - *<http://riskfactor.cancer.gov/measurementerror/>*
- Method to develop fish consumption distributions from NHANES 2003-2006 data assuming:
 - There is an underlying fish consumption distribution for the population.
 - An individual's fish consumption varies from day to day.
 - Each individual has some probability of consuming fish on any given day.
 - There may be a correlation between the frequency of fish consumption and the amount of fish consumed.

EPA's FCR for national criteria

- Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010) Final Report, April 2014 EPA-820-R-14-002

<http://water.epa.gov/scitech/swguidance/fishshellfish/fishadvories/upload/Estimated-Fish-Consumption-Rates-for-the-U-S-Population-and-Selected-Subpopulations-NHANES-2003-2010.pdf>

- Modeling based on NCI method
- 90th percentile FCR is 22 grams per day

Properties of an ideal fish consumption survey for AWQC development

1. Representative of population
2. Characterizes consumption of desired groups
3. Rates not suppressed due to environmental contamination
4. Characterizes range of fish consumption median, average, upper percentiles.
5. Addresses consumption of relevant species.
6. Addresses consumption of relevant fish preparations
7. Accounts for temporal variation in fish consumption

Representativeness

- Sample must be similar to the population in order for us to use the survey to make conclusions about the population.
- Sample should either:
 - Contain the same composition of different groups as the population (e.g. genders, ages, incomes, ethnicities).
 - Plan for use of weighting factors that can be used to adjust survey results so that they reflect the population.
- Tribal enrollment records useful in developing representative samples.

Required sample size: non response

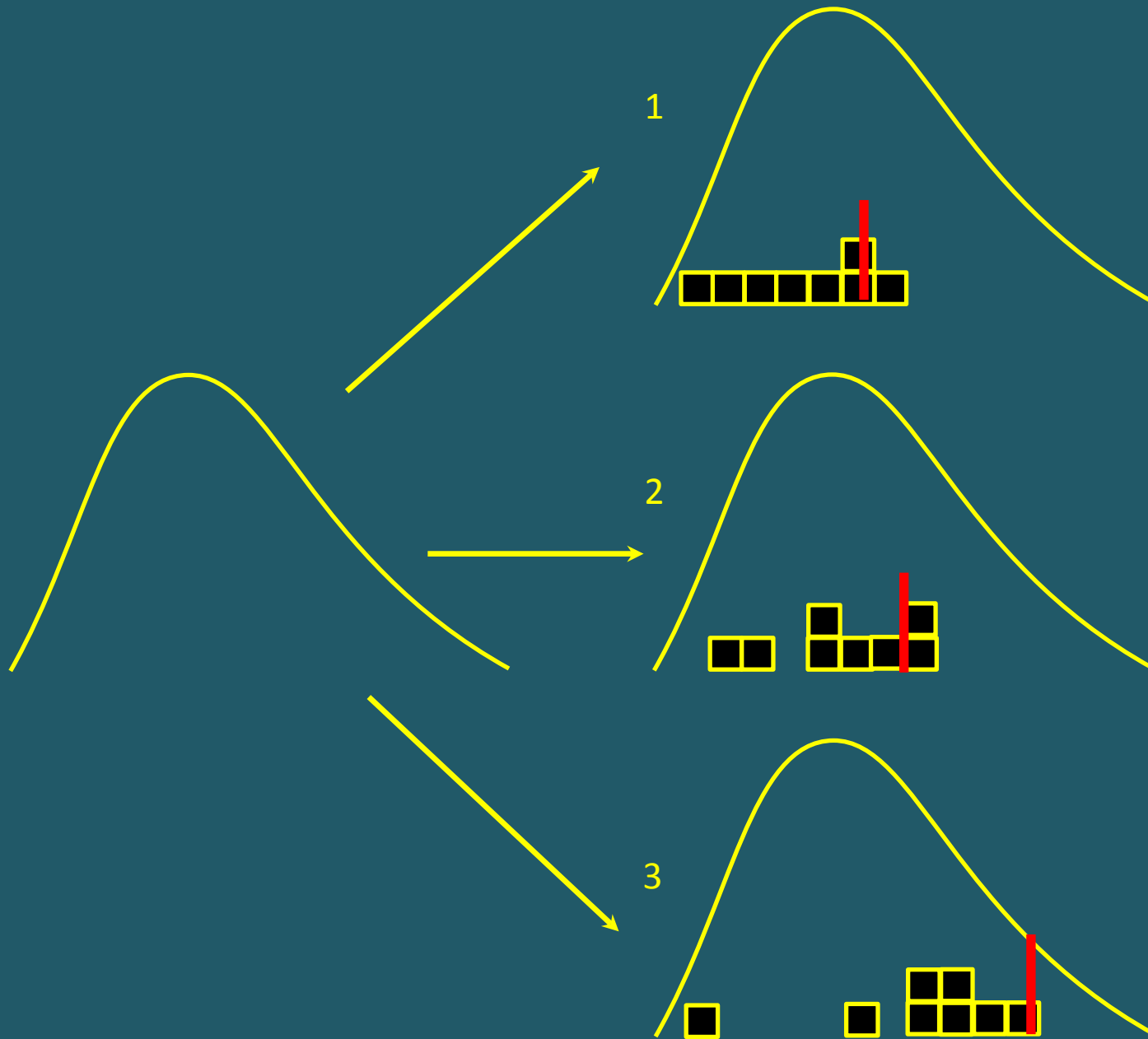
- Not everyone contacted will participate.
- Sample size must be larger to accommodate non-response.
- Sample size = desired responses \div probability of responding

Required sample size (FFQ): stability of average

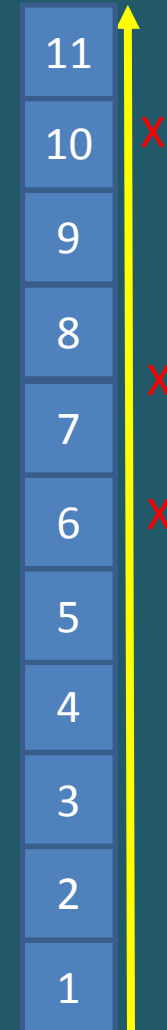
- Based on desired percent difference between the mean and an upper confidence limit on the mean.
- Regional tribal surveys computed sample size assuming log normal FCR distributions and 95% UCL is 20% > mean
 - $\exp(1.96 \times \text{SDV} / \text{SqRt}(n) \times \text{SqRt}(1 - n/N)) = 1.2$
 - Where: N = population size, n = sample size, SDV = standard deviation

Required sample size (FFQ): stability of percentiles

- Use a “bootstrap” approach
- Using an assumed fish consumption log normal distribution, sample N times.
- Compute percentile of interest (e.g. 95th).
- Repeat many times.
- Look at spread of percentile estimates.
- Evaluate whether or not spread is sufficiently narrow.



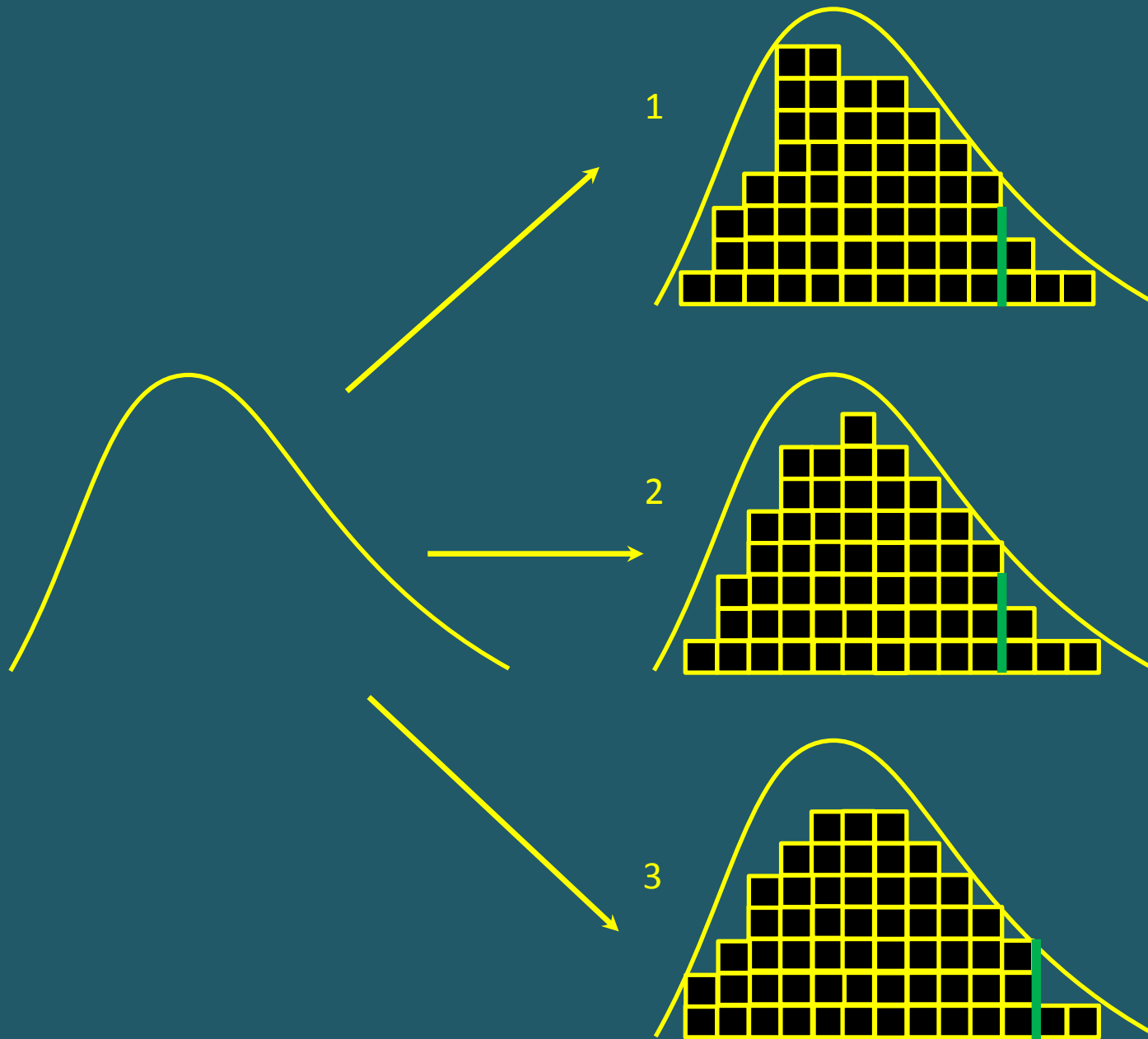
95th Percentile of
Sample



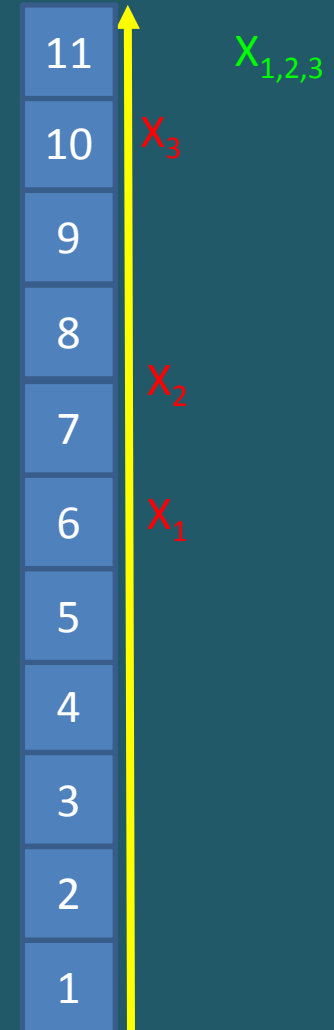
x_3

x_2

x_1



95th Percentile of
Sample



Required sample size (NCI)

- NCI method based on results of two 24 hour recall interviews.
- In order to conduct modeling, a rule of thumb is that there must be 50 interviews where an individual recorded fish consumption on both interview days (i.e. a double hit).
- Sample size = $50 \div (\text{Probability of consuming fish})^2$
- Sample size can be large if probability of fish consumption is small.
- Can be problematic for characterizing consumption of highly specific fish groupings (e.g. fish caught from state waters).

Data collection instruments

Refer to table: Comparing data collection instruments

- Personal interview
- Creel survey
- Mail
- Internet
- Telephone
- Diary

Derived from: U.S. EPA 1998, Guidance for Conducting Fish and Wildlife Consumption Surveys, U.S. EPA, Science and Technology, EPA-823-B-98-007

Accounting for temporal trends in fish consumption

- Consumption impacted by conditions at the time of interview.
 - What was recently consumed
 - Availability of fish
- Approaches for dealing with temporal trends
 - Repeat interviews of individuals over time
 - Interview fractions of sample population over time
 - Creel surveys: Conduct interviews throughout the fishing season and cover relevant times

Data analysis

- Outliers
 - Real or errors?
 - Affects statistics
 - Accuracy of upper percentile rates
 - Impact on average consumption
- Weighting: Adjusting representativeness of FCRs obtained from different groups within a sample population to reflect the population the survey will be applied to.

Survey quality considerations

- Formation of a planning group with appropriate membership.
- Pilot testing of survey with subsequent modification.
- Interviewer training
- Re-interviewing
- Data analysis and data quality measures clearly defined and documented
- Peer review and potentially publication

Heritage Rates: FCRs pre Lewis and Clark

- Methods
 - Direct observation of catch and population size estimates
$$\text{FCR} = \frac{\text{fish per day per site} \times \# \text{ of fishing days per year} \times \# \text{ of sites} \times \text{lb per fish} \times \text{grams per pound}}{365 \text{ days per year} \times \text{Native American population}}$$
 - Caloric basis:
$$\text{FCR} = \frac{\text{calories required for daily activity} \times \text{fraction of diet consisting of fish}}{\text{caloric content of fish}}$$
 - Ethnographic analysis
 - Wabanaki study (Harper and Ranco 2009), <http://www.epa.gov/region1/govt/tribes/pdfs/DITCA.pdf>
 - Spokane Tribe (Harper et al. 2001), <http://www.ncbi.nlm.nih.gov/pubmed/12088230>
- Heritage rates are estimates of “central tendency” or average consumption. Not possible to get upper percentiles or distributions.

Suppression

Is reduction in fish consumption from historic rates due to a variety of causes.

- Fears of chemical contamination
- Reduced fish populations due to loss of habitat or chemical contamination
- Changes in social structure such that harvesting is reduced
- Loss of access to fishing locations
- Laws or regulations restricting fishing
- Inadequate fishing gear

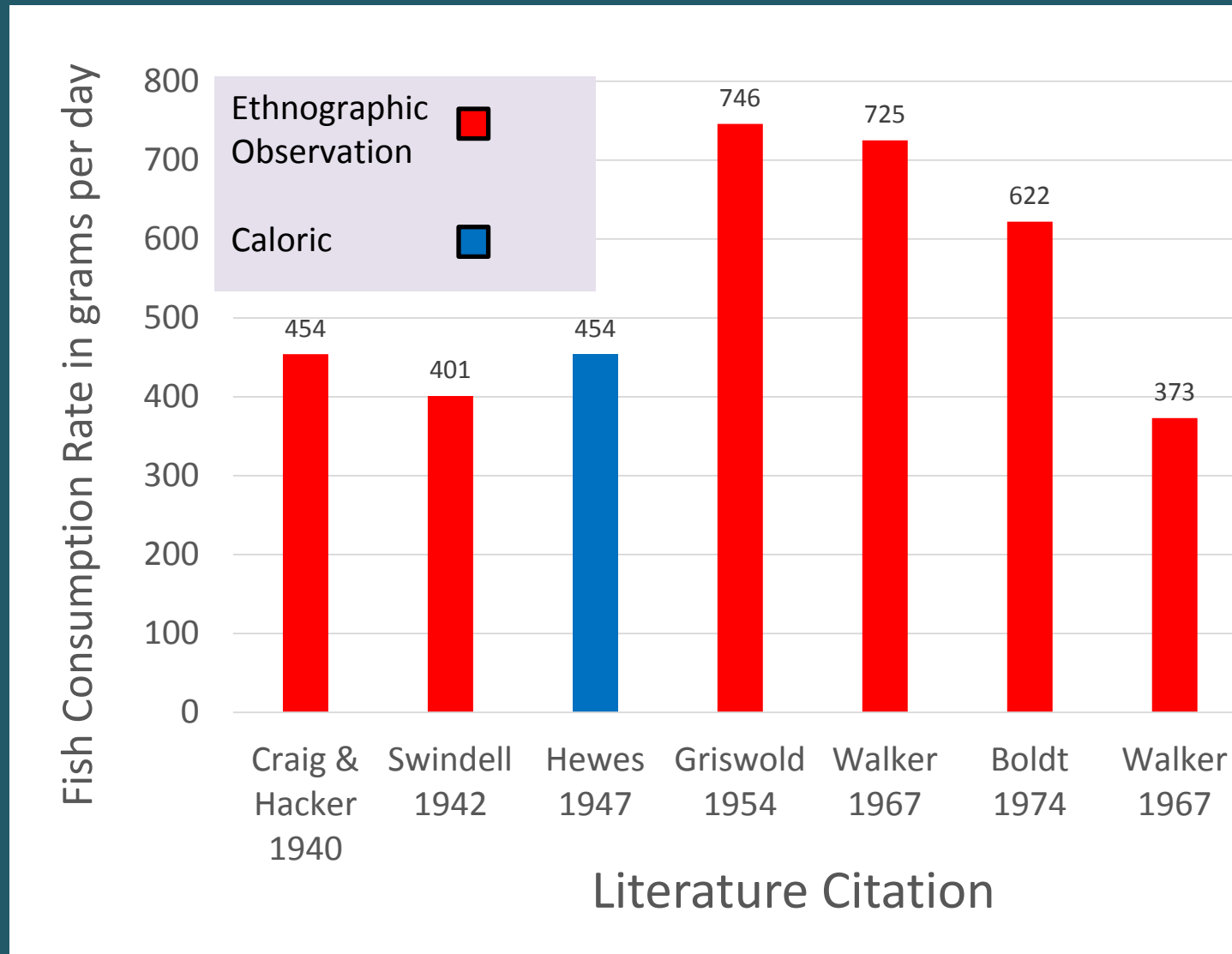
Implications of Suppression

When environmental agencies employ a FCR that does not capture fully the consumption that is suppressed – under either scenario in which suppression effects occur – they set in motion a sort of downward spiral whereby the resulting environmental standards permit further and further contamination or depletion of the fish and so diminished health and safety of people consuming fish, shellfish, aquatic plants, and wildlife for subsistence, traditional, cultural, or religious purposes.

(NEJAC 2002)

http://www.epa.gov/environmentaljustice/resources/publications/nejac/fish-consump-report_1102.pdf

Example Heritage Rates for Columbia River Tribes





United States
Environmental Protection
Agency

Office of Water
(4305)

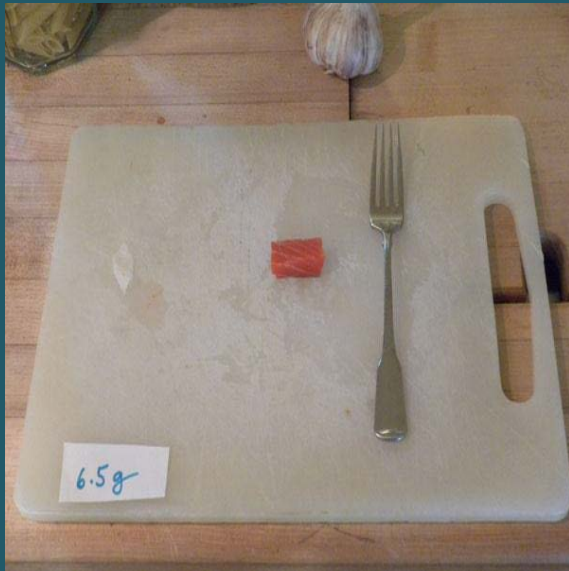
EPA-823-B-98-007
November 1998

Guidance for Conducting Fish and Wildlife Consumption Surveys



- Published in 1998
- Currently undergoing peer review
- Includes information on:
 - Characterizing heritage or historic fish consumption
 - Computer assisted personal interview software

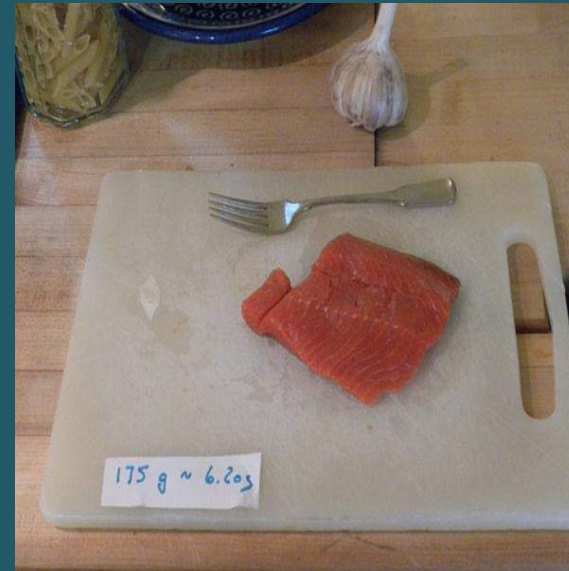
Visualizing Fish Portion Sizes (Ecology 2013)



6.5 g or 2.3 oz



54 g or 1.9 oz



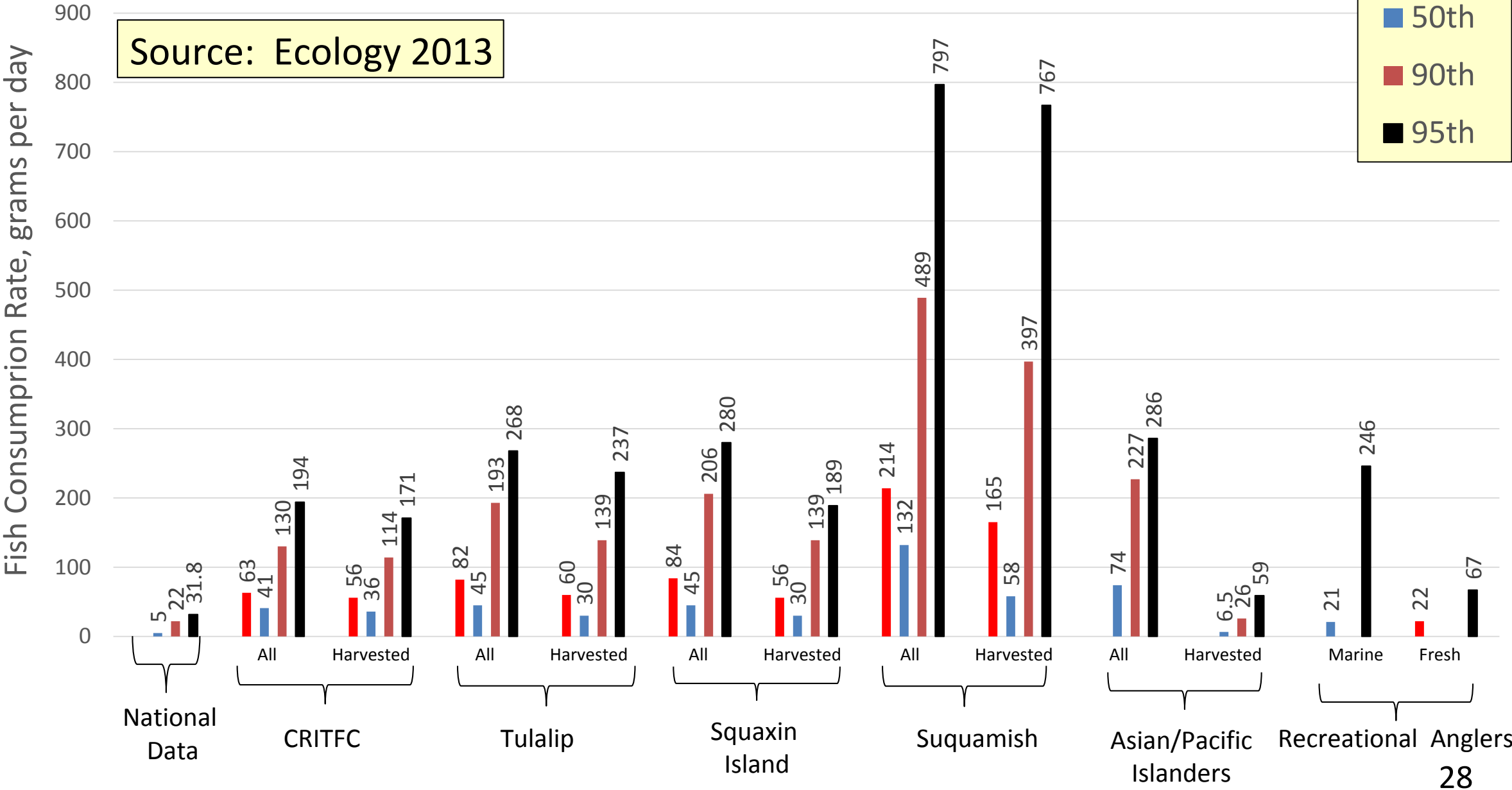
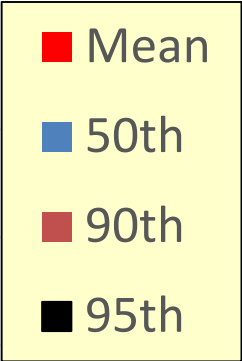
175 g or 6.2 oz



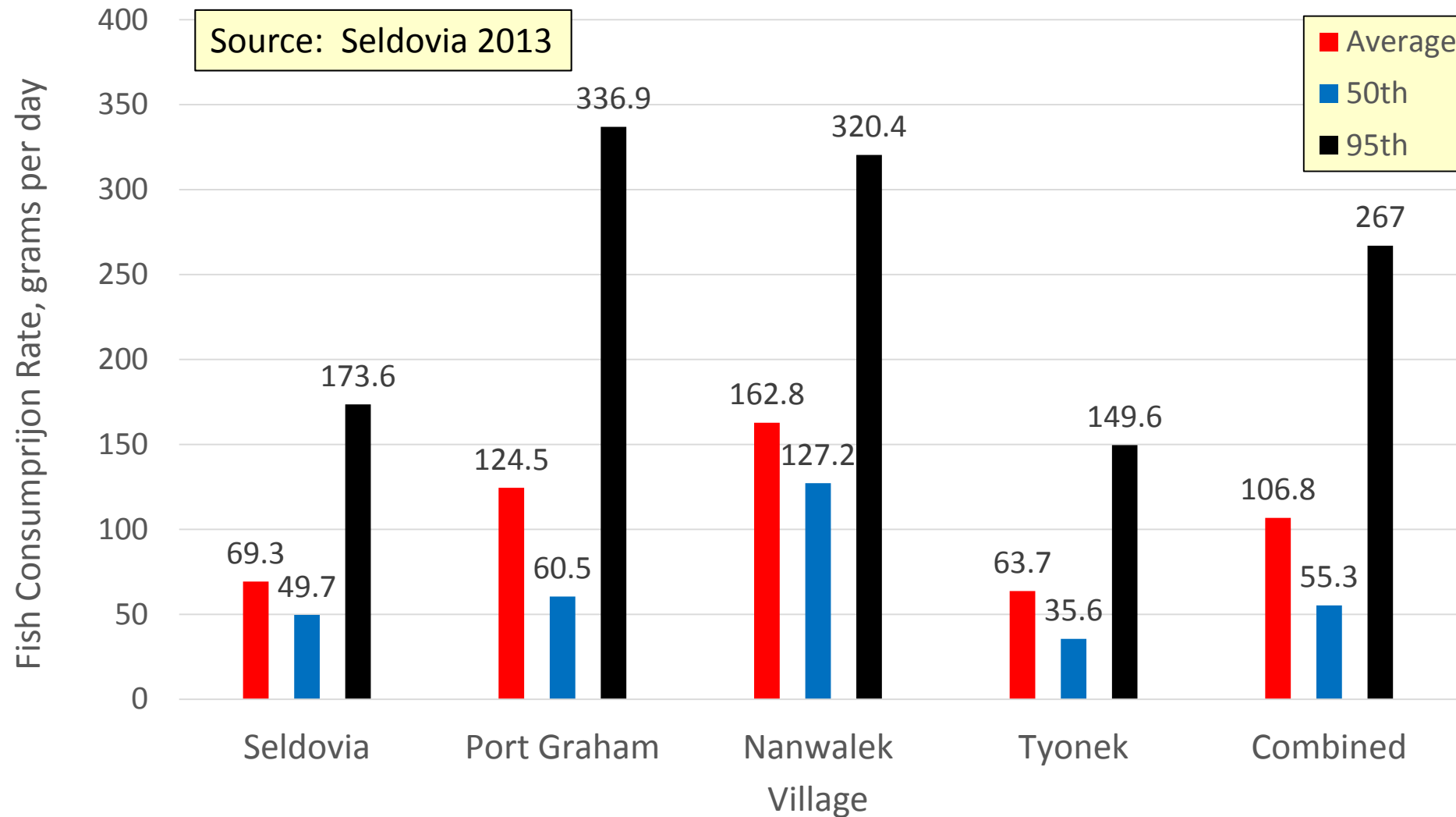
226.8 g or 8 oz

Comparison of FCRs

Source: Ecology 2013



Fish Consumption Rates for Cook Inlet Tribes



Use of FFQ and NCI Approaches in Region 10

- Most of the existing surveys in Region 10 have been FFQs.
- Surveys were designed without collaboration with nutritional epidemiologists.
- Idaho surveys represent one of the first opportunities to compare FFQ and NCI approaches.
- Need to determine how to proceed.
- NCI approach is complicated and data intensive for tribes with limited resources.
- General feeling is that the NCI method is more accurate.
- Difficult to get NCI rates for very specific groups of fish.

Consumption of near coastal/estuarine/fresh water fish by the Nez Perce (NPT) and Shoshone Bannock (SBT) Tribes.

